

CHUKA

UNIVERSITY



## UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN  
FOOD SCIENCE AND TECHNOLOGY

ICEN 206: ENGINEERING PRINCIPLES

STREAMS: BSc. FOST

TIME: 2 HOURS

DAY/DATE: MONDAY 14/04/2025

2.30 P.M. – 4.30 A.M.

**INSTRUCTIONS**

- Answer question ONE and TWO other questions

Take:

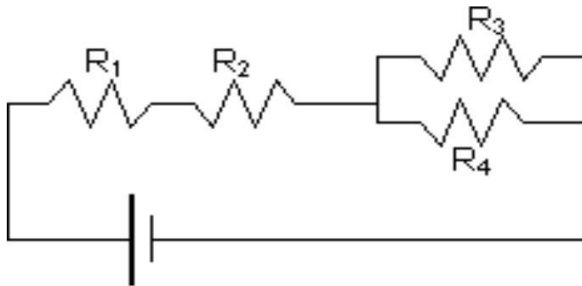
Permittivity in free space  $\epsilon_0 = 8.85 \times 10^{-12} \text{C}/(\text{Nm}^2)$ Charge of electron  $e^- = 1.6 \times 10^{-19} \text{C}$  $\mu_0 = 4\pi \times 10^{-7} \text{Tm/A}$  $C = 3 \times 10^8 \text{ m/s}$  $m_e = 1.67262 \times 10^{-27} \text{ Kg}$  $m_p = 9.1 \times 10^{-31} \text{ Kg}$  $g = 9.8 \text{ N/kg}$  or  $9.8 \text{ ms}^{-2}$ Seconds per yr =  $3.156 \times 10^7 \text{ s/yr}$  $G = 6.67 \times 10^{-11} \text{ N.M}^2\text{kg}^{-2}$ 

$$K = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2\text{c}^{-2}$$

**QUESTION ONE**

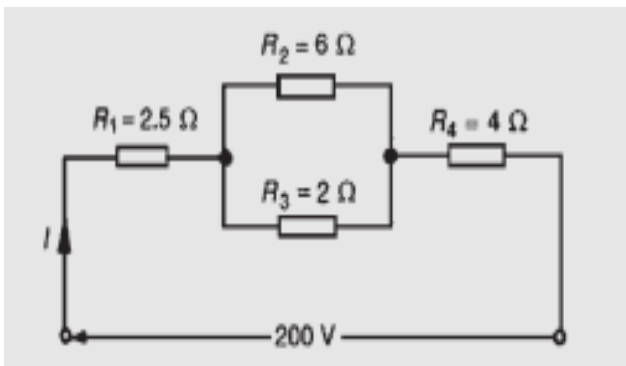
- Define a linear and a non linear device giving an example in each. (4 marks)
- A parallel plate capacitor has  $2.00 \text{ cm}^2$  plates that are separated by  $2.0 \text{ mm}$  with air between them. If a  $24.0 \text{ V}$  battery is connected to this capacitor, how much energy does it store? (3 marks)
- An e.m.f. of  $220 \text{ V}$  is connected across a resistance and the current flowing through the resistance is  $11 \text{ A}$ . What is the power developed? (3 marks)

- d) Calculate the resistance per unit length of a 22-gauge nichrome wire of radius 0.42mm.  
 Resistivity of the wire is  $2.5 \times 10^{-6} \Omega \cdot m$ . ii. If a potential of 20.0V is maintained across a 1.0m length of nichrome wire. What is what is current in the wire? (4 marks)
- e) The mutual inductance between two coils is 300 mH. Find the magnitude of the e.m.f. induced in one coil when the current in the other is increasing at a rate of 30 A/s. (4 marks)
- f) What is the equivalent resistance of this circuit Fig. 1?  $R_1 = 2\Omega$ ,  $R_2 = 4\Omega$ ,  $R_3 = 6\Omega$ ,  $R_4 = 8\Omega$ . Calculate the current delivered from the battery of 12 V. (4 marks)



**Figure 1**

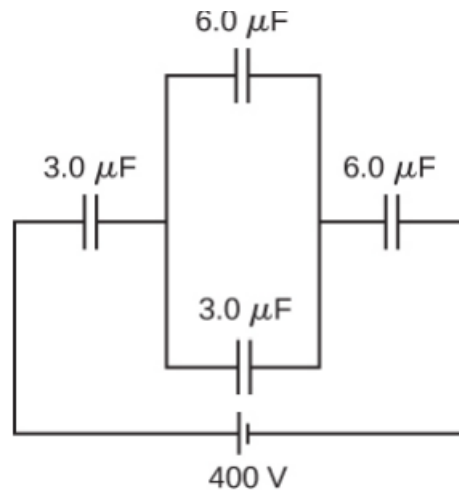
- g) State the three essential devices required by an analogue electrical indicating instruments require (3 marks)
- h) Describe Two electronic instruments. (2 marks)
- i) For the series-parallel circuit shown in Fig. 2, find (i) the supply current, (ii) the current flowing through each resistor . (3 marks)



**Figure 2**

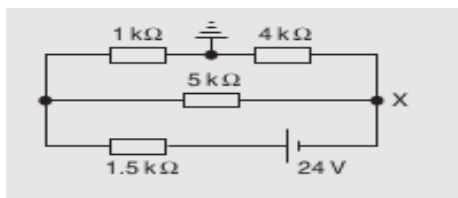
**QUESTION TWO**

- a. Calculate the equivalent capacitance of the circuit and the total charge across the circuit in Fig. 3. (5 marks)



**Figure 3**

- b. For the circuit shown in Fig. 4, calculate (i) the voltage drop across the 4 kΩ resistor, (ii) the current through the 5 kΩ resistor, (iii) the power developed in the 1.5 kΩ resistor. (6 marks)



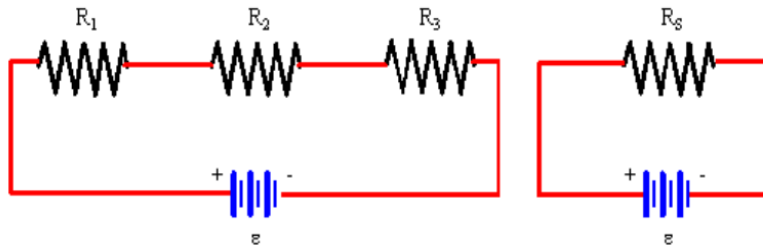
**Fig. 4**

- c. A mass of 1200 g is accelerated at  $200 \text{ cm/s}^2$  by a force. Calculate the value of the force (2 marks)
- d. Describe Primary cells and secondary cells giving example in each. (3 marks)
- e. Ten cells, each with an internal resistance of  $0.2 \Omega$  and an e.m.f. of 2.4 V are connected (i) in series, (ii) in parallel. Determine the e.m.f. and the internal resistance of the batteries so formed. (4 marks)

**QUESTION THREE**

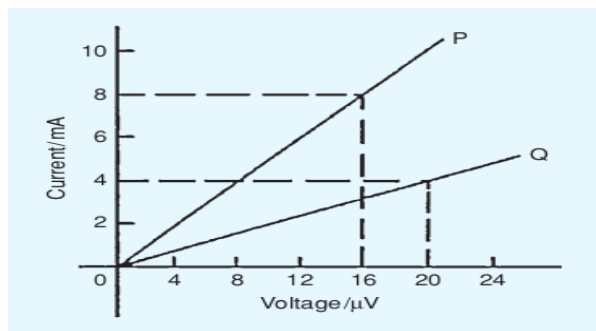
- a) An electric heater is operated by applying a potential difference of 200V to a nichrome wire of total resistance  $8\Omega$ . Find the current carried by the wire and the Power rating of the heater. If the heater is operated daily for 4 hours how much will it cost to pay electricity bill at the end 30 days. One kWh costs 25.0 shillings. (4 marks)

- b) In the **Fig.4**  $R_1 = 3 \Omega$ ,  $R_2 = 5 \Omega$ , and  $R_3 = 6 \Omega$ . The battery supplies an emf of  $\varepsilon = 18.0 \text{ V}$ . What is the equivalent resistance,  $R_S$ ? What is the current through each resistor? What is the voltage drop across each resistor? What is the power expended in the  $6 \Omega$  resistor? (4 marks)



**Figure. 4**

- c) A  $12 \mu \text{ F}$  capacitor is required to store  $4 \text{ J}$  of energy. Find the p.d. to which the capacitor must be charged. (2 marks)
- d) A  $60 \text{ W}$  electric light bulb is connected to a  $240 \text{ V}$  supply. Determine (i) the current flowing in bulb and (ii) the resistance of the bulb. (2 marks)
- e) Graphs of current against voltage for two resistors P and Q are shown in Fig. 5. Determine the value of each resistor. (4 marks)



**Figure 5**

- f) In a household during a particular week three  $2 \text{ kW}$  iron boxes are used on average  $18 \text{ h}$  each and twenty  $50 \text{ W}$  light bulbs are used on average  $35 \text{ h}$  each. Determine the cost of electricity for the week if 1 unit of electricity costs 25 shillings. (4 marks)

#### QUESTION FOUR

- a) Find the accelerating force when a car having a mass of  $3.4 \times 10^3 \text{ kg}$  increases its speed with a constant acceleration of  $8 \text{ m/s}^2$  (3 marks)

- b) A force of 80 N moves an object 20m in the direction of the force. What amount of work is done?  
(3 marks)
- c) Name Three factors which can effect the resistance of a conductor (3 marks)
- d) Calculate the largest number of 100 W electric light bulbs which can be operated from a 240 V supply fitted with a 13 A fuse. (3marks)
- e) Determine the resistance of 1600 m of copper cable having a diameter of 12 mm if the resistivity of copper is  $1.7 \times 10^{-8} \Omega \text{ m}$ . (4 marks)
- f) The resistance of a coil of aluminium wire at  $18^\circ \text{C}$  is  $200 \Omega$ . The temperature of the wire is increased and the resistance rises to  $240 \Omega$ . If the temperature coefficient of resistance of aluminium is  $0.0039/^\circ \text{C}$  at  $18^\circ \text{C}$  determine theoretical temperature to which the coil has risen. (4 marks)

**QUESTION FIVE**

- a) A current of 10 A is passed through a 2000-turn coil wound on a circular magnetic circuit of radius 100 mm. Calculate (i)the magnetomotive force, and (ii) the magnetic field strength. (4 marks)
- b) A solenoid 20 cm long is wound with 500 turns of wire. Find the current required to establish a magnetising force of 2500 A/m inside the solenoid. (4 marks)
- c) A conductor 400 mm long carries a current of 10 A and is at right-angles to a magnetic field lying between two circular pole faces each of radius 40 mm. If the total flux between the pole faces is 0.5 mWb, calculate the magnitude of the force exerted on the conductor. (4 marks)
- d) State Lenz's and Faraday's law of induction (4 marks)
- e) The wing span of a metal aeroplane is 18 m. If the aeroplane is flying at 400 km/h, determine the e.m.f. induced between its wing tips. Assume the vertical component of the earth's magnetic field is  $80 \mu\text{T}$ . (4 marks)
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